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(54) **A FLUID OPERATED ACTUATOR INCLUDING A BLEED PORT**

FLUIDBETÄTIGTER STELLANTRIEB MIT ABLASSANSCHLUSS

ACTIONNEUR FLUIDIQUE AVEC UNE SORTIE POUR DÉBIT DE FUITE

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Description

TECHNICAL FIELD

[0001] The present invention relates to fluid operated actuator. More particularly, the present invention relates to a fluid operated actuator including a bleed port.

BACKGROUND OF THE INVENTION

[0002] Fluid operated actuators convert a fluid pressure to a work piece using an actuator that typically consists of a piston in a cylinder. Although there are various suitable fluids that may be used, the fluid applied to the actuator generally comprises pneumatic or hydraulic fluid, for example. Pneumatic operated actuators are generally used where the compressibility of air is desired or to obtain much higher flow rates and thus faster response times while hydraulic operated actuators are generally employed when high actuating forces are required. Both fluids have advantages and in some situations, either pneumatic or hydraulic fluid may be used.

[0003] Although fluid operated cylinders are generally known in the art, one particular type of fluid operated cylinder comprises an impact cylinder. Impact cylinders, also known as drop hammers, are generally known in the art and used for a variety of applications. Impact cylinders may be powered using a variety of different fluids or other actuators; however, it is particularly common to use fluid pressure, such as pneumatic or hydraulic fluid, to pressurize the impact cylinder. Generally, fluid pressure is introduced into a first fluid chamber resulting in the movement of a piston. Towards the end the piston's stroke, it collides with a secondary piston or other striking member. The striking member then rapidly extends from the cylinder body, thereby impacting some work piece. Another variation is to omit the striking member and have a piston rod, coupled to the piston, strike the work piece directly.

[0004] Impact cylinders can be used for a number of applications. For example, in waste combustion plants, deposits can form on the exhaust pipes resulting in the pipes becoming clogged. An impact cylinder can be coupled to the exhaust pipes and when actuated, the striking pin impacts the exterior of the pipe to break loose and de-cake the inside of the pipe. With a single strike of the striking pin, the pipe can continue to vibrate to break loose more deposits.

[0005] Although impact cylinders have received great success, one potential problem encountered when using impact cylinders is rebound striking by the striking pin. Rebound striking can occur when the striking pin impacts either the work piece or the piston multiple times during the course of a single piston stroke. In use, the rear cylinder chamber of the main piston is rapidly pressurized in order to actuate the piston with sufficient force and speed. However, after actuation, this pressure remains in the rear cylinder and also acts on the striking pin, pre-

venting the striking pin from fully retracting. If this pressure is not exhausted, the striking pin can impact the work piece multiple times, which may not be desirable. Prior art attempts to provide exhaust valves to vent the rear cylinder chamber typically takes a significant amount of time and requires complex control systems and large ventilators resulting in increased expense. United States Patent 3,469,400 made some improvement in the return time of the piston by incorporating a bleed port, which after a predetermined time period, equilibrates the pressure on either side of the piston. However, the '400 patent does not include a movable striking pin and therefore does not provide an efficient process for returning the striking pin to accommodate the newly improved return speed of the piston.

[0006] Therefore, there exists a need for an impact cylinder that can rapidly compensate for the force acting on the main piston after the impact cylinder has been actuated. The present invention overcomes this and other problems and an advance in the art is achieved.

SUMMARY OF THE INVENTION

[0007] A fluid operated actuator is provided according to an embodiment of the invention. The fluid operated actuator includes a cylinder body and a piston.

[0008] The piston is movable within the cylinder between a first and a second position and defines a first chamber and a second chamber. The fluid operated actuator includes a fluid inlet formed in the first chamber. A bleed port is formed to provide fluid communication between the first chamber and the second chamber, a striking pin is positioned within the second chamber, and a biasing member coupling the striking pin to the piston is provided.

[0009] According to an embodiment of the invention, a method for operating a fluid operated actuator is provided. The fluid operated actuator includes a piston movable within a cylinder and defining a first chamber and a second chamber. The fluid operated actuator also includes an inlet formed in the first chamber and a bleed port providing fluid communication between the first chamber and the second chamber.

[0010] The method comprises the steps of pressurizing the first chamber through the inlet and actuating the piston away from a first position towards a second position. The method also comprises the step of bleeding at least some of the pressure in the first chamber into the second chamber through the bleed port as the piston is actuated towards the second position. The method also comprises the step of retracting a striking pin using a biasing member coupling the striking pin to the piston, as the piston moves from the second position to the first position.

[0011] According to an embodiment of the invention, an adjustable relief valve can be coupled to the cylinder body and configured to regulate a pressure in the first chamber.

[0012] According to an embodiment of the invention, an adjustable relief valve for a fluid operated actuator comprises a valve housing and a poppet movable within a poppet chamber formed in the valve housing. A biasing member can be coupled to the poppet. According to an embodiment of the invention, an adjustable member is provided that is movable within the valve housing and adapted to adjust a biasing force acting on the poppet by the biasing member.

[0013] According to an embodiment of the invention, a method for controlling a pressure in a fluid operated actuator is provided. The fluid operated actuator also includes an adjustable relief valve coupled to the first chamber. The method comprises the step of biasing a poppet of the adjustable valve against a valve seat formed in an exhaust formed in the first chamber with a biasing member. The method also comprises adjusting a biasing force of the biasing member with an adjustable member coupled to the biasing member. The method further comprises actuating the poppet away from the valve seat when a pressure in the first chamber reaches a threshold pressure required to overcome the biasing force, thereby regulating a pressure in the first chamber acting on the piston.

ASPECTS

[0014] According to an aspect of the invention, a fluid operated actuator comprises:

- a cylinder body;
- a piston movable within the cylinder body between a first position and a second position, the piston defining a first chamber and a second chamber;
- a fluid inlet formed in the first chamber; and
- a bleed port providing fluid communication between the first chamber and the second chamber.

[0015] The fluid operated actuator further comprises a striking pin positioned within the second chamber.

[0016] The fluid operated actuator further comprises a biasing member coupling the striking pin to the piston.

[0017] Preferably, the bleed port is formed in the piston.

[0018] Preferably, the bleed port is formed in the cylinder body.

[0019] Preferably, the bleed port comprises a cross sectional area smaller than the inlet port.

[0020] Preferably, the fluid operated actuator further comprises a fluid outlet formed in the second chamber.

[0021] Preferably, the fluid operated actuator further comprises a check valve positioned in the fluid outlet.

[0022] Preferably, the fluid operated actuator further comprises an exhaust port formed in the first chamber.

[0023] Preferably, the fluid operated actuator further comprises an adjustable valve configured to control fluid communication between the first chamber and the exhaust port.

[0024] According to another aspect of the invention, a method for controlling a fluid operated actuator including a piston movable within a cylinder and defining a first chamber and a second chamber, an inlet formed in the first chamber, and a bleed port providing fluid communication between the first chamber and the second chamber, the method comprises the steps of:

- pressurizing the first chamber through the inlet;
- actuating the piston away from a first position towards a second position; and
- bleeding at least some of the pressure in the first chamber into the second chamber through the bleed port as the piston is actuated towards the second position,
- retracting a striking pin using a biasing member coupling the striking pin to the piston, as the piston moves from the second position towards the first position

[0025] Preferably, the method further comprises the step of impacting a striking pin with the piston as the piston reaches the second position.

[0026] Preferably, the method further comprises the step of exhausting the first chamber thereby actuating the piston from the second position towards the first position.

[0027] Preferably, the method further comprises the step of actuating a check valve provided in a fluid outlet formed in the second chamber to open the fluid outlet thereby exhausting the second chamber.

[0028] Preferably, the method further comprises the step of regulating the pressure within the first chamber using a pressure relief valve.

[0029] Preferably, the pressure relief valve comprises an adjustable pressure relief valve.

[0030] Preferably, the bleed port is formed in the piston.

[0031] Preferably, the bleed port is formed in the cylinder body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

FIG. 1 shows a partial cross-sectional view of an impact cylinder according to an embodiment of the invention.

FIG. 2 shows a partial cross-sectional view of the impact cylinder according to another embodiment of the invention.

FIG. 3 shows a partial cross-sectional view of the impact cylinder according to an embodiment not part of the invention.

FIG. 4 shows a schematic of the impact cylinder powered by a centralized fluid source.

FIG. 5 shows a cross sectional view of an adjustable valve according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0033] FIGS. 1 -5 and the following description depict specific examples to teach those skilled in the art how to make and use the best mode of the invention. For the purpose of teaching inventive principles, some conventional aspects have been simplified or omitted. Those skilled in the art will appreciate variations from these examples that fall within the scope of the invention. Those skilled in the art will appreciate that the features described below can be combined in various ways to form multiple variations of the invention. As a result, the invention is not limited to the specific examples described below, but only by the claims and their equivalents.

[0034] FIG. 1 shows a partial cross-sectional view of a fluid operated actuator 100 according to an embodiment of the invention. According to the embodiment shown, the fluid operated actuator 100 comprises an impact cylinder 100. Although an impact cylinder is described below, it should be appreciated that the present invention is not limited to impact cylinders, but rather the present invention may be utilized with any kind of fluid operated actuator. The invention is particularly well suited for fluid operated actuators that require pressure compensation after a fast initial stroke. The impact cylinder 100 comprises a cylinder body 101, a piston 102, a striking pin 103, and an end cap 104. According to an embodiment of the invention, the end cap 104 can be coupled to the cylinder body 101 after the internal components have been inserted. The end cap 104 may be coupled to the cylinder body 101 according to known methods including, for example adhesives, welding, brazing, bonding, mechanical fasteners, etc. The particular method used to couple the end cap 104 to the cylinder body 101 should not limit the scope of the present invention. According to another embodiment of the invention, the end cap 104 can be omitted and the cylinder body 101 can be formed around the internal components. According to an embodiment of the invention, the impact cylinder 100 can also include fasteners 120. The fasteners 120 may comprise bolts or screws, or some other type of fastener. The fasteners 120 can be provided to couple the impact cylinder 100 to a work piece or some other device.

[0035] According to an embodiment of the invention, the piston 102 can be movable within the cylinder body 101 between a first position (shown in FIG. 1) and at least a second position (towards the striking pin 103). The piston 102 may include one or more sealing members (not shown) to provide a substantially fluid tight seal between the piston 102 and the cylinder body 101. According to an embodiment of the invention, the piston 102 separates the cylinder body 101 into a first chamber 105 and a second chamber 106. The first chamber 105 may be pressurized via a fluid inlet 107. The fluid inlet 107 may be formed in the first chamber 105 as shown. The pressurized fluid may comprise pneumatic, hydraulic, or some other fluid. Therefore, when pressurized fluid is initially supplied to the impact cylinder 100, the first chamber 105

becomes pressurized and as a result, the piston 102 is actuated away from a first position, which is the position shown in FIG. 1, towards a second position, which is towards the striking pin 103. As the first chamber 105 is pressurized, the piston 102 can be actuated towards the striking pin 103 and can eventually impact the striking pin 103. As a result of the impact from the piston 102, the striking pin 103 rapidly extends from the cylinder body 101 to collide or otherwise impact an exterior work piece, such as a pipe, for example. The pressurized fluid being supplied to the inlet port 107 can then be shut off and an exhaust valve may be actuated to open an exhaust port 112 in order to exhaust the first chamber 105. According to the embodiment shown, the exhaust valve comprises an adjustable valve 111; however, it should be appreciated that the exhaust valve may comprise any type of exhaust valve and the particular valve chosen should not limit the scope of the present invention. The exhaust valve 111 may be actuated in a variety of ways including, but not limited to solenoid actuated, fluid actuated, pilot actuated, manually actuated, etc. In some embodiments, the exhaust port 112 may not be able to exhaust the pressure within the first chamber 105 fast enough to prevent the striking pin 103 from rebound striking. Another undesirable condition may exist if the striking pin 103 bounces off from the work piece and the piston 102 and the pressure within the first chamber 105 is still elevated such that the piston 102 remains in an actuated position thereby colliding with the striking pin 103 a second time as the striking pin bounces off from the work piece. Both of these conditions can be substantially reduced according to the present invention.

[0036] According to an embodiment of the invention, the cylinder 100 can be provided with a bleed port 110. The bleed port 110 may provide fluid communication between the first and second fluid chambers 105, 106. Although the bleed port 110 is shown as being formed in the piston 102, it should be appreciated that the bleed port 110 may be formed in the cylinder body 101 instead (See FIG. 2). According to the embodiment shown in FIG. 1, the cross sectional area of the bleed port 110 is smaller than the cross sectional area of the inlet port 107. Therefore, although pressurized fluid in the first chamber 105 can communicate with the second chamber 106 via the bleed port 110, the smaller cross sectional area of the bleed port 110 results in the pressure in the first chamber 105 increasing faster than the pressure in the second chamber 106. As a result, the piston 102 can still be actuated and strike the striking pin 103 before the fluid between the first chamber 105 and the second chamber 106 can equilibrate. However, the bleed port 110 allows the pressure in the second chamber 106 to increase and thus, at least partially compensates for the increased pressure in the first chamber 105. The pressure in the second chamber 106 will also increase due to the reduced volume as the piston 102 is actuated towards the second position. With the bleed port 110 provided, once the pressure is no longer being supplied to the inlet port

107, the piston 102 substantially immediately begins to return towards its first position as some of the fluid in the high pressure first chamber 105 bleeds into the lower pressure second chamber 106.

[0037] According to an embodiment of the invention, the piston 102 is coupled to the striking pin 103 via a biasing member 130. The biasing member 130 may comprise a spring as shown, or may comprise some other biasing member. The biasing member 130 may be provided to bias the striking pin 103 towards the piston 102. Therefore, as the piston 102 returns to its rest position, the biasing member 130 can act to pull the striking pin 103 back into the cylinder body 101. This substantially immediate withdrawal of both the piston 102 and the striking pin 103 can prevent the striking pin 103 from rebound striking the work piece.

[0038] In addition to decreasing the pressure in the first chamber 105 via the bleed port 110, the adjustable valve 111 can also be actuated in order to remove the pressurized fluid from the first chamber 105 via the first chamber exhaust 112. The adjustable valve 111 may be actuated once the piston 102 has completed its stroke, for example. The adjustable valve 111 may comprise a variety of different types of valves; however, the adjustable valve 111 shown in FIG. 1 comprises an adjustable poppet style valve comprising a poppet 113, a biasing member 114, an adjusting member 115, a locking pin 116, and a protective cap 117. According to an embodiment of the invention, the adjustable valve 111 may be utilized to both exhaust the first chamber 105 when actuated, but also function as a pressure relief valve that can regulate the pressure within the first chamber 105. For example, if it is desired to provide a pressure of 5 bar to the first chamber 105, however the pressurized fluid source is set to 10 bar, the adjustable valve 111 can be adjusted to open at just above 5 bar. The adjustment may be accomplished using the adjusting member 115, which can adjust the compression of the biasing member 114 that biases the poppet 113 against the exhaust 112. Once the adjustable valve 111 is set to the desired position, the locking pin 116 can be inserted into the adjustable valve 111 in order to retain the adjusting member 115 in the set position. Advantageously, the adjustment member 115 will not fall out of place due to vibrations or other external forces. The cap 117 can then be coupled to the adjustable valve 111 in order to protect the adjustable valve 111 from dirt and debris. With the adjustable valve 111 set to just above 5 bar, pressure within the first chamber 105 can be retained around 5 bar regardless of the inlet pressure supplied to the inlet port 107. It should be appreciated that the pressures described above are merely examples and the particular operating pressures may differ. Therefore, the present invention should not be limited to the pressures described above.

[0039] In order to exhaust the first chamber 105, the adjustable valve 111 can be actuated to open a fluid flow path between the first chamber 105 and the exhaust 112. Although not shown, the adjustable valve 111 may in-

clude an actuation means, such as a solenoid, for example. Other methods of actuating the adjustable valve 111 are known as discussed above, and the particular method used should not limit the scope of the present invention. According to an embodiment of the invention, the exhaust 112 has a larger cross sectional area than the bleed port 110. As a result, fluid in the first chamber 105 can exit the actuator 100 through the exhaust 112 faster than it can flow through the bleed port 110. Therefore, once the exhaust 112 is opened, the piston 102 can rapidly return to its first rest position. As the pressure in the first chamber 105 decreases, some of the fluid pressure within the second chamber 106 may flow through the bleed port 110. The remaining pressure in the second chamber 106 can be exhausted from the system through the fluid outlet 108.

[0040] According to an embodiment of the invention, the fluid outlet 108 can be formed in the second chamber 106. In some embodiments, the fluid outlet 108 may also include a check valve 109. In some embodiments, the fluid outlet 108 may be in communication with a pressurized fluid source. The pressurized fluid source may be used to close the check valve 109, for example. According to an embodiment of the invention, the pressurized fluid source acting on the check valve 109 may comprise the same fluid source that delivers pressurized fluid to the inlet port 107. However in other embodiments, the check valve 109 may be supplied with pressure from a separate source and therefore, the particular fluid source acting on the check valve 109 should not limit the scope of the present invention. The check valve 109 may be provided to prevent fluid from exiting the fluid outlet 108 when the pressurized fluid source is provided. In other words, the pressurized fluid source may keep the check valve 109 from opening thereby preventing any premature exhausting of the second fluid chamber 106. Once the pressure is removed from the check valve 109, fluid within the second fluid chamber 106 may be free to exit through the fluid outlet 108 formed in the second fluid chamber 106. According to an embodiment of the invention, the check valve 109 may be retained closed during actuation of the piston 102 from the first position towards the second position in order to prevent fluid in the second chamber 106 from exhausting prematurely and eliminating the advantages created by the bleed port 110. In other embodiments, the fluid outlet 108 can be omitted and substantially all of the pressure within the second chamber 106 can be exhausted through the exhaust 112.

[0041] In use, the cylinder 100 starts in an initial rest or first piston position. This is the position shown in FIG. 1. With the piston 102 in its first position, the biasing member 130 can act to bias the striking pin 103 towards a retracted position. Furthermore, the first and second chambers 105, 106 can be substantially depressurized or may comprise equal pressures. To actuate the piston 102, pressurized fluid can be supplied to the first chamber 105 via the inlet port 107. In some embodiments, pressurized fluid may also be supplied to the check valve 109

to prevent fluid in the second chamber 106 from exhausting through port 108. The pressure created in the first chamber 105 actuates the piston 102 such that the piston 102 moves within the cylinder body 101 from a first position to a second position. According to an embodiment of the invention, the second position is towards the striking pin 103. Once the piston 102 impacts the striking pin 103, the striking pin 103 extends from the cylinder body 101 due to the force of the piston 102. As described above, as the piston 102 is being actuated, a portion of the fluid in the first chamber 105 bleeds into the second chamber 106 via the bleed port 110 formed in the piston 102. Therefore, the pressure in the second chamber 106 increases in response to the moving piston 102. The pressure in the second chamber 106 increases due to the reduction in volume of the second chamber 106 as well as the pressure bleeding into the second chamber 106 from the first chamber 105 via the bleed port 110. As a result, the increased pressure in the second chamber 106 can partially compensate or cushion the force from pressure in the first chamber 105 acting on the piston 102 with the increased pressure in the second chamber 106. Therefore, the piston 102 is less susceptible to rebound striking.

[0042] Once it is desired to return the piston 102 to its first position, the pressure supplied to the first chamber 105 via the inlet port 107 can be removed and the exhaust valve 111, which may comprise the adjustable valve 111, can be actuated, thereby opening the exhaust port 112. With the exhaust port 112 open to the first chamber 105, the first chamber 105 can begin to exhaust. With the pressure still in the second chamber 106, the piston 102 is actuated back towards the first position. Because the bleed port 110 is much smaller than the exhaust port 112, fluid is exhausted from the first chamber 105 at a faster rate than it is supplied from the second chamber 106 via the bleed port 110.

[0043] In addition to the opening of the exhaust 112, the pressure being applied to the check valve 109 can be removed thereby allowing fluid remaining in the second chamber 106 to be exhausted through the fluid outlet 108.

[0044] FIG. 2 shows the cylinder 100 according to another embodiment of the invention. The cylinder 100 shown in FIG. 2 is similar to the cylinder shown in FIG. 1 with a few exceptions. In FIG. 2, the bleed port 110 is formed in the cylinder body 101 rather than in the piston 102. However, the function and capabilities of the bleed port 110 shown in FIG. 2 are comparable to the embodiment shown in FIG. 1. It should also be appreciated that the bleed port 110 may be formed outside of the cylinder body 101 using a separate conduit, for example.

[0045] In addition, the embodiment shown in FIG. 2 includes a separate pressure relief port 217. The pressure relief port 217 can be provided to exhaust the first chamber 105 if the pressure exceeds a threshold pressure. The threshold pressure may be adjusted by adjusting the pressure relief valve 111 as described further be-

low. By providing separate and distinct pressure relief ports 217 and exhaust ports 112 a number advantages can be realized. According to some embodiments, the pressure relief valve 111 can be adjusted to a desired threshold pressure and no further input is required to open the pressure relief port 217. Rather, if the pressure within the first chamber 105 exceeds the threshold pressure, the pressure relief valve 111 will open automatically.

[0046] Another advantage to providing a separate pressure relief port 217 is that fluid through the inlet port 107 and the exhaust port 112 may be controlled using a single valve. For example, a 2/2 valve may be utilized where pressurized fluid is supplied to the inlet port 107 and the exhaust port 112 is closed when the valve is in a first position and where the fluid supply is closed off from the inlet port 107 and the exhaust port 112 is opened when the valve is in a second position. In some embodiments, the fluid outlet 108 and the exhaust port 112 may be coupled such that both can be operated substantially simultaneously in order to completely vent the cylinder 100. It should be appreciated that the valves described may comprise generally known valves and therefore the particular manner of actuation has been omitted.

[0047] FIG. 3 shows the cylinder 100 according to an embodiment not covered by the invention. In the embodiment shown in FIG. 3, the striking pin 103 is coupled directly to the piston 102 and forms a piston rod. Therefore, the biasing member 130 is no longer necessary. The operation of the cylinder 100 of FIG. 3 is similar to the previously described embodiments. However, the piston 102 no longer impacts the striking pin 103; rather the striking pin 103 is actuated with the piston 102. Therefore, the cylinder 100 essentially comprises a traditional piston/cylinder arrangement however, the piston 102 is provided with the bleed port 110.

[0048] In some embodiments, the fluid actuated cylinder 100 may be connected to a centralized fluid source with multiple fluid actuated cylinders connected in series. Therefore, certain measures may need to be taken in order to prevent loss of the pressurized fluid. This is described further below with reference to FIG. 4.

[0049] FIG. 4 shows a simplified schematic of an impact cylinder system 400 according to an embodiment of the invention. The system 400 includes the impact cylinder 100 coupled to a centralized fluid source 420 according to an embodiment of the invention. The electronics for actuating the valves have been omitted to simplify the drawings. As shown, the embodiment in FIG. 4 includes the centralized fluid source 420, a first control valve 421, a second control valve 422, and a fluid reservoir 423. The system shown in FIG. 4 may be advantageous in situations where the impact cylinder 100 shares the centralized fluid source 420 with one or more other devices (not shown). If other devices also utilize the centralized fluid source 420, the pressure may fluctuate if appropriate precautionary steps are not taken.

[0050] As shown, the first control valve 421 can control

the delivery of the pressurized fluid from the centralized fluid source 420 to the cylinder 100. According to the embodiment shown, the valve 421 comprises a 3/2 valve; however, it should be appreciated that the valve 421 may comprise a variety of configurations and the particular valve configuration chosen should not limit the scope of the present invention. With the valve 421 actuated to open a fluid flow path from the centralized fluid source 420 to the cylinder 100, the fluid can be delivered to the second valve 422 via the line 425. The line 425 also branches off into line 427, which provides fluid communication to the check valve 109 and the fluid outlet 108. The line 425 also branches off to line 426, which provides fluid communication to the reservoir 423. The functions of these branches will be described in more detail below.

[0051] According to an embodiment of the invention, the second control valve 422 can be provided to open a fluid flow path from the first control valve 421 to the fluid inlet 107 of the cylinder 100 via line 428.

[0052] Operation of the system shown in FIG. 4 can be accomplished as follows. With the piston 102 in a first piston position as shown in FIG. 4, the first control valve 421 can be actuated according to known methods. Once actuated, the valve 421 can open a fluid flow path via line 424 from the centralized fluid source 420 and the check valve 109, the second control valve 422, and the fluid reservoir 423. It should be appreciated that once the first valve 421 is actuated, the check valve 109 can be closed by the pressure delivered via the line 427, thereby preventing fluid from escaping from the second chamber 106 through the fluid outlet 108. In addition, with the first control valve 421 actuated, the fluid reservoir 423 can be pressurized. The fluid reservoir 423 may be advantageous in preventing a rapid loss of pressure delivered to the cylinder 100 in the event that multiple additional devices are actuated at the same time, thereby temporarily depleting the pressure of the centralized fluid source 420.

[0053] According to an embodiment of the invention, the pressure supplied from the first control valve 421 can also be used to actuate the second control valve 422 once the pressure acting on the second control valve 422 reaches a threshold pressure. The threshold pressure may not be reached immediately upon actuating the first control valve 421 if the reservoir 423 needs to be filled as the majority of pressure will be delivered to the reservoir 423. It should be appreciated that in other embodiments, the second control valve 422 may be actuated according to other known methods rather than relying upon the pressure supplied via the first control valve 421. Once the threshold pressure is reached, or the second control valve 422 is otherwise actuated, fluid can be delivered to the fluid inlet 107 of the cylinder 100 via the supply line 428. As fluid is delivered to the fluid inlet 107, the cylinder 100 can be actuated as discussed above.

[0054] The pressure delivered to the fluid inlet 107 can act on the piston 102 to actuate the piston 102 from the first position towards the second position. In addition to the actuation of the piston 102, a portion of the pressu-

rized fluid delivered to the first chamber 105 can bleed into the second chamber 106 via the bleed port 110. Therefore, the pressure within the second chamber 106 is also increased. If the pressure within the first chamber 105 exceeds a threshold pressure, the adjustable valve 111 may actuate to relieve or otherwise regulate the pressure within the first chamber 105.

[0055] Once the piston 102 reaches or nears the end of its stroke, the first control valve 421 can be de-actuated, thereby closing off the pressurized fluid source from the first control valve 421. As the pressure within the reservoir 423 begins to drain, the pressure actuating the second control valve 422 will also decrease and eventually the second control valve 422 can de-actuate thereby closing off the pressurized source to the inlet 107. The de-actuation of the first control valve 421 may be determined based on a predetermined actuation time, for example. Other methods of control are contemplated including a position sensor (not shown) on the piston 102 or the striking pin 103, for example.

[0056] Upon de-actuating the second valve 422, the adjustable valve 111 may substantially simultaneously be actuated to exhaust the first chamber 105. Actuation of the adjustable valve 111 may be accomplished according to generally known methods including a solenoid, or some other electrical actuation, fluid actuation, etc. The particular method used for actuating the adjustable valve 111 should not limit the scope of the present invention. As the first chamber 105 exhausts through the exhaust port 112, the piston moves back towards the first position.

[0057] With the first control valve 421 de-actuated and open to exhaust, the pressure acting on the check valve 109 also decreases. Once the pressure acting on the check valve 109 drops below the pressure in the second chamber 106, the check valve 109 will open to allow the second chamber 106 to exhaust.

[0058] FIG. 5 shows the adjustable valve 111 according to an embodiment of the invention. FIG. 5 shows the adjustable valve 111 in a little more detail than previously shown. As can be seen, the adjustable valve 111 can be inserted into the cylinder housing 101 and sealed using sealing members 550. The sealing members 550 may comprise O-rings, for example; or may comprise some other sealing member. Advantageously, the sealing members 550 can provide a substantially fluid tight seal between the adjustable valve 111 and the cylinder housing 101. According to an embodiment of the invention, the adjustable valve 111 can be positioned within the cylinder housing 101 such that the poppet 113 seals against a valve seat 552 formed in the end of the cylinder 100. One of the poppet 113 or the valve seal 552 may include a sealing member (not shown) to aid in the fluid tight seal formed when the poppet 113 rests against the valve seal 552.

[0059] According to an embodiment of the invention, the adjustable valve 111 also includes a biasing member 114. The biasing member 114 can be provided to bias

the poppet 113 against the valve seal 552. Advantageously, the poppet 113 can be sized such that the poppet 113 is movable within a poppet chamber 553 formed in the adjustable valve 111. According to an embodiment of the invention, the poppet 113 can be provided with a sealing member 551 that provide a substantially fluid tight seal between the poppet 113 and the poppet chamber 553.

[0060] As discussed briefly above, the adjustable valve 111 may be provided as a pressure relief valve in the end of the impact cylinder 100. Therefore, if the pressure within the first chamber 105 exceeds a threshold pressure, the adjustable valve 111 will actuate to relieve the excess pressure. Advantageously, the pressure within the first chamber 105 can be regulated using the adjustable valve 111. The threshold pressure at which the adjustable valve 111 actuates can be adjusted using the adjustable member 115. The adjustable member 115 may engage the adjustable valve housing 554 using threads (not shown). The threads allow the adjustable member 115 to be screwed inward or outward (left to right as shown in FIG. 5) in order to adjust the compression of the biasing member 114. As the biasing member 114 is coupled between the poppet 113 and the adjustable member 115, the force required to unseat the poppet 113 is determined at least in part by the compression experienced by the biasing member 114. As can be appreciated, in order to increase the threshold pressure at which the poppet 113 unseats from the valve seat 552, the adjustable member 115 can be screwed inward, thereby compressing the biasing member 114. Conversely, to decrease the threshold pressure at which the poppet 113 unseats from the valve seat 552, the adjustable member 115 can be screwed outward, thereby relieving some of the compression of the biasing member 114. It should be appreciated that the allowable threshold pressure range can be determined based on the particular biasing member 114 used.

[0061] Once the desired compression is reached, a locking pin 116 can be inserted. The locking pin 116 can engage the adjustable member 115 and the valve housing 554 in order to lock the position of the adjustable member 115. Therefore, with the locking pin 116 in place, the adjustable member 115 will not move and thereby change the threshold pressure under vibrations caused by operation of the cylinder 100. According to an embodiment of the invention, the locking pin 116 can engage a groove 555 formed in the adjustable member 115. Although only one groove 555 is shown in FIG. 5, it should be appreciated that the locking pin 116 is engaging another groove that is not visible with the locking pin 116 in place. The adjustable member 115 may include any number of grooves 555 and the particular number of grooves may depend upon the number of lockable positions desired. For example, in the embodiment shown, the adjustable member 115 includes two lockable positions because two grooves are provided. Therefore, the adjustable member 115 can be locked into place every

one-half of a turn. It should be appreciated however, that any number of lockable positions may be provided.

[0062] It should be appreciated that while the adjustable valve 111 is shown in conjunction with the impact cylinder 100, the adjustable valve 111 can be used with any type of impact cylinder.

[0063] The detailed descriptions of the above embodiments are not exhaustive descriptions of all embodiments contemplated by the inventors to be within the scope of the invention as defined by the following claims.

Claims

1. A fluid operated actuator (100), comprising:
 - a cylinder body (101);
 - a piston (102) movable within the cylinder body (101) between a first position and a second position, the piston (102) defining a first chamber (105) and a second chamber (106);
 - a fluid inlet (107) formed in the first chamber (105);
 - a bleed port (110) providing fluid communication between the first chamber (105) and the second chamber (106);
 - a striking pin (103) positioned within the second chamber (106); and
- characterized by:
 - a biasing member (103) coupling the striking pin (103) to the piston (102).
2. The fluid operated actuator (100) of claim 1, wherein the bleed port (110) is formed in the piston (102).
3. The fluid operated actuator (100) of claim 1, wherein the bleed port (110) is formed in the cylinder body (101).
4. The fluid operated actuator (100) of claim 1, wherein the bleed port (110) comprises a cross sectional area smaller than the inlet port (107).
5. The fluid operated actuator (100) of claim 1, further comprising a fluid outlet (108) formed in the second chamber (106).
6. The fluid operated actuator (100) of claim 5, further comprising a check valve (109) positioned in the fluid outlet (108).
7. The fluid operated actuator (100) of claim 1, further comprising an exhaust port (112) formed in the first chamber (105).
8. The fluid operated actuator (100) of claim 7, further

comprising an adjustable valve (111) configured to control fluid communication between the first chamber (105) and the exhaust port (112).

9. A method for controlling a fluid operated actuator including a piston movable within a cylinder and defining a first chamber and a second chamber, an inlet formed in the first chamber, and a bleed port providing fluid communication between the first chamber and the second chamber, the method comprising the steps of:

pressurizing the first chamber through the inlet; actuating the piston away from a first position towards a second position; bleeding at least some of the pressure in the first chamber into the second chamber through the bleed port as the piston is actuated towards the second position; and

characterized by:

retracting a striking pin using a biasing member coupling the striking pin to the piston, as the piston moves from the second position towards the first position.

10. The method of claim 9, further comprising the step of impacting a striking pin with the piston as the piston reaches the second position.
11. The method of claim 9, further comprising the step of exhausting the first chamber thereby actuating the piston from the second position towards the first position.
12. The method of claim 9, further comprising the step of actuating a check valve provided in a fluid outlet formed in the second chamber to open the fluid outlet thereby exhausting the second chamber.
13. The method of claim 9, further comprising the step of regulating the pressure within the first chamber using a pressure relief valve.
14. The method of claim 13, wherein the pressure relief valve comprises an adjustable pressure relief valve.
15. The method of claim 9, wherein the bleed port is formed in the piston or in the cylinder body.

Patentansprüche

1. Fluidbetätigter Stellantrieb (100) mit:
einem Zylinderkörper (101);
einem Kolben (102), der in dem Zylinderkörper

(101) zwischen einer ersten Position und einer zweiten Position bewegbar ist, wobei der Kolben (102) eine erste Kammer (105) und eine zweite Kammer (106) definiert;

einem in der ersten Kammer (105) gebildeten Fluideinlass (107);
einem Ablassanschluss (110), der eine Fluidverbindung zwischen der ersten Kammer (105) und der zweiten Kammer (106) bereitstellt;
einem in der zweiten Kammer (106) angeordneten Schlagbolzen (103); und
gekennzeichnet durch
ein Vorspannglied (103), das den Schlagbolzen (103) mit dem Kolben (102) koppelt.

2. Fluidbetätigter Stellantrieb (100) nach Anspruch 1, wobei der Ablassanschluss (110) in dem Kolben (102) gebildet ist.
3. Fluidbetätigter Stellantrieb (100) nach Anspruch 1, wobei der Ablassanschluss (110) in dem Zylinderkörper (101) gebildet ist.
4. Fluidbetätigter Stellantrieb (100) nach Anspruch 1, wobei der Ablassanschluss (110) eine kleinere Querschnittsfläche aufweist als der Einlassanschluss (107).
5. Fluidbetätigter Stellantrieb (100) nach Anspruch 1, ferner mit einem in der zweiten Kammer (106) gebildeten Fluidauslass (108).
6. Fluidbetätigter Stellantrieb (100) nach Anspruch 5, ferner mit einem in dem Fluidauslass (108) angeordneten Rückschlagventil (109).
7. Fluidbetätigter Stellantrieb (100) nach Anspruch 1, ferner mit einem in der ersten Kammer (105) gebildeten Entleerungsanschluss (112).
8. Fluidbetätigter Stellantrieb (100) nach Anspruch 7, ferner mit einem einstellbaren Ventil (111), das konfiguriert ist, eine Fluidverbindung zwischen der ersten Kammer (105) und dem Entleerungsanschluss (112) zu steuern.
9. Verfahren zur Steuerung eines fluidbetätigten Stellantriebs, der einen in einem Zylinder bewegbaren und eine erste Kammer und eine zweite Kammer definierenden Kolben, einen in der ersten Kammer gebildeten Einlass und einen eine Fluidverbindung zwischen der ersten Kammer und der zweiten Kammer bereitstellenden Ablassanschluss aufweist, wobei das Verfahren die folgenden Schritte aufweist:

Unterdrucksetzen der ersten Kammer durch den Einlass;
Betätigen des Kolbens weg von einer ersten Po-

sition hin zu einer zweiten Position;
Ablassen mindestens eines Teils des Drucks,
der in der ersten Kammer herrscht, in die zweite
Kammer durch den Ablassanschluss, wenn der
Kolben hin zu der zweiten Position betätigt wird;
und

gekennzeichnet durch:

Zurückziehen eines Schlagbolzens unter Ver-
wendung eines den Schlagbolzen mit dem Kol-
ben koppelnden Vorspannglieds, wenn sich der
Kolben aus der zweiten Position hin zu der ers-
ten Position bewegt.

10. Verfahren nach Anspruch 9, ferner mit dem Schritt:
Stoßen eines Schlagbolzens mit Hilfe des Kolbens,
wenn der Kolben die zweite Position erreicht.
11. Verfahren nach Anspruch 9, ferner mit dem Schritt:
Entleeren der ersten Kammer, wodurch der Kolben
aus der zweiten Position hin zur ersten Position be-
tätigt wird.
12. Verfahren nach Anspruch 9, ferner mit dem Schritt:
Betätigen eines Rückschlagventils, das in einem in
der zweiten Kammer gebildeten Fluidauslass bereit-
gestellt ist, um den Fluidauslass zu öffnen und da-
durch die zweite Kammer zu entleeren.
13. Verfahren nach Anspruch 9, ferner mit dem Schritt:
Regulieren des Drucks in der ersten Kammer unter
Verwendung eines Druckentlastungsventils.
14. Verfahren nach Anspruch 13, wobei das Druckent-
lastungsventil ein einstellbares Druckentlastungs-
ventil aufweist.
15. Verfahren nach Anspruch 9, wobei der Ablassan-
schluss in dem Kolben oder in dem Zylinderkörper
gebildet ist.

Revendications

1. Actionneur fluide (100) comprenant :

un corps cylindrique (101),
un piston (102) mobile dans le corps cylindrique
(101) entre une première position et une secon-
de position, ce piston (102) définissant une pre-
mière chambre (105) et une seconde chambre
(106),
une entrée de fluide (107) formée dans la pre-
mière chambre (105),
un orifice de fuite (110) permettant le passage
de fluide entre la première chambre (105) et la
seconde chambre (106),

un percuteur (103) située dans la seconde
chambre (106), et **caractérisé par** un élément
de précontrainte (130) couplant le percuteur
(103) au piston (102).

2. Actionneur fluide (100) conforme à la revendica-
tion 1,
dans lequel l'orifice de fuite (110) est formé dans le
piston (102).
3. Actionneur fluide (100) conforme à la revendica-
tion 1,
dans lequel l'orifice de fuite (110) est formé dans le
corps cylindrique (101).
4. Actionneur fluide (100) conforme à la revendica-
tion 1,
dans lequel l'orifice de fuite (110) a une section trans-
versale dont la surface est inférieure à celle de l'ori-
fice d'entrée (107).
5. Actionneur fluide (100) conforme à la revendica-
tion 1,
comprenant en outre une sortie de fluide (108) for-
mée dans la seconde chambre (106).
6. Actionneur fluide (100) conforme à la revendica-
tion 5,
comprenant en outre une soupape anti-retour (109)
située dans la sortie de fluide (108).
7. Actionneur fluide (100) conforme à la revendica-
tion 1,
comprenant en outre un orifice d'évacuation (112)
formé dans la première chambre (105).
8. Actionneur fluide (100) conforme à la revendica-
tion 7,
comprenant en outre une soupape réglable (111)
susceptible de commander le passage du fluide en-
tre la première chambre (105) et l'orifice d'évacua-
tion (112).
9. Procédé de commande d'un actionneur fluide
comprenant un piston mobile dans un cylindre et dé-
finissant une première chambre et une seconde
chambre, une entrée formée dans la première cham-
bre et un orifice de fuite permettant le passage de
fluide entre la première chambre et la seconde
chambre, ce procédé comprenant des étapes consti-
tant à :

mettre la première chambre sous pression par
l'entrée,
actionner le piston pour le faire passer d'une pre-
mière position vers une seconde position,
évacuer au moins une partie de la pression de
la première chambre dans la seconde chambre

par l'orifice de fuite lorsque le piston est actionné vers la seconde position, et

caractérisé par

- une étape consistant à rétracter un percuteur en utilisant un élément de précontrainte couplant ce percuteur au piston lorsque le piston se déplace de la seconde position vers la première position. 5
10. Procédé conforme à la revendication 9, comprenant en outre une étape consistant à frapper un percuteur avec le piston lorsque le piston atteint la seconde position. 10
11. Procédé conforme à la revendication 9, comprenant en outre une étape consistant à évacuer la première chambre en actionnant le piston à partir de la seconde position vers la première position. 15
12. Procédé conforme à la revendication 9, comprenant en outre une étape consistant à actionner une soupape anti-retour montée dans une sortie de fluide formée dans la seconde chambre pour ouvrir la sortie de fluide et par suite évacuer la seconde chambre. 20
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13. Procédé conforme à la revendication 9, comprenant en outre une étape consistant à réguler la pression dans la première chambre en utilisant une soupape de sureté. 30
14. Procédé conforme à la revendication 13, selon lequel la soupape de sureté est une soupape de sureté réglable. 35
15. Procédé conforme à la revendication 9, selon lequel l'orifice de fuite est formé dans le piston ou dans le corps cylindrique. 40

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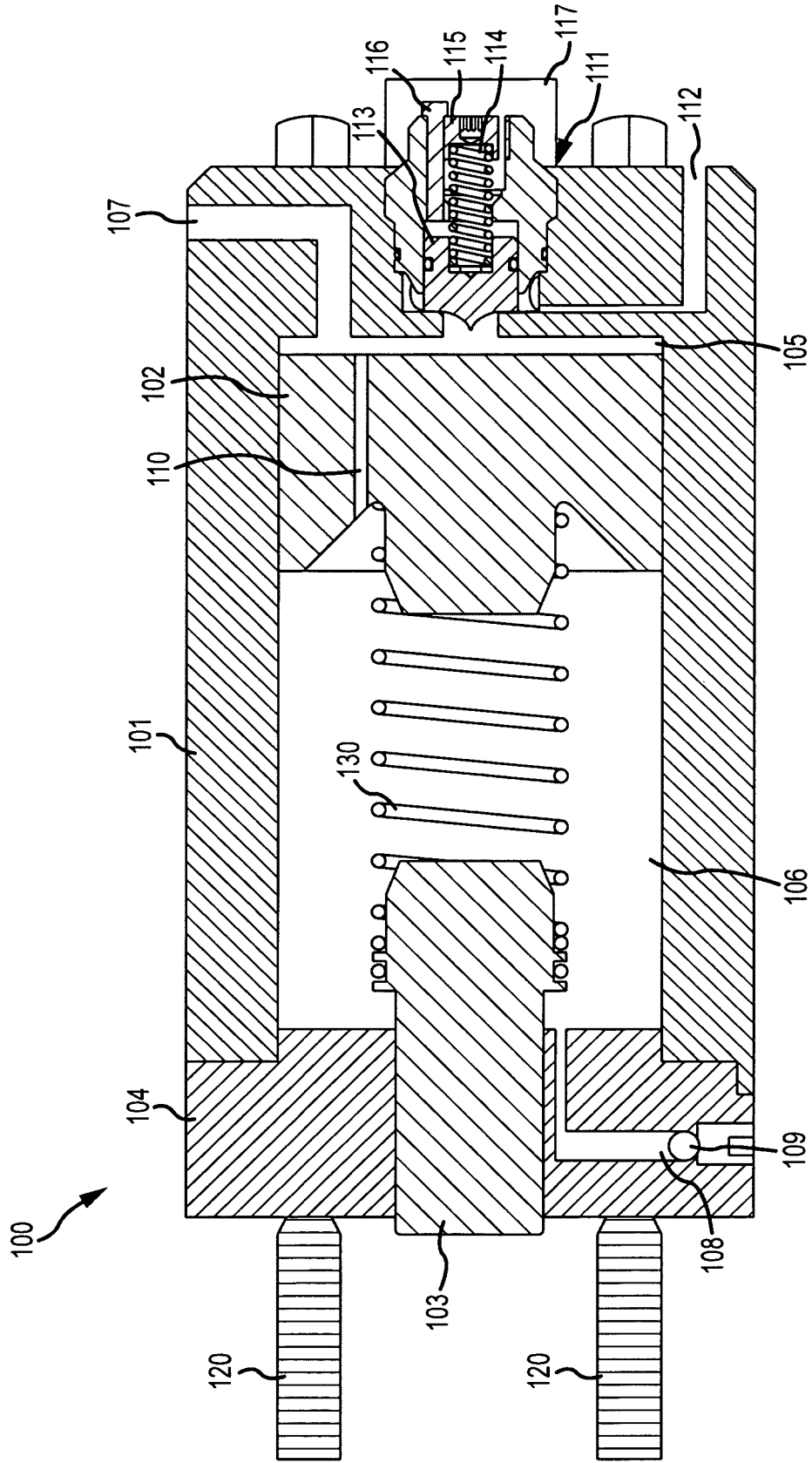


FIG. 1

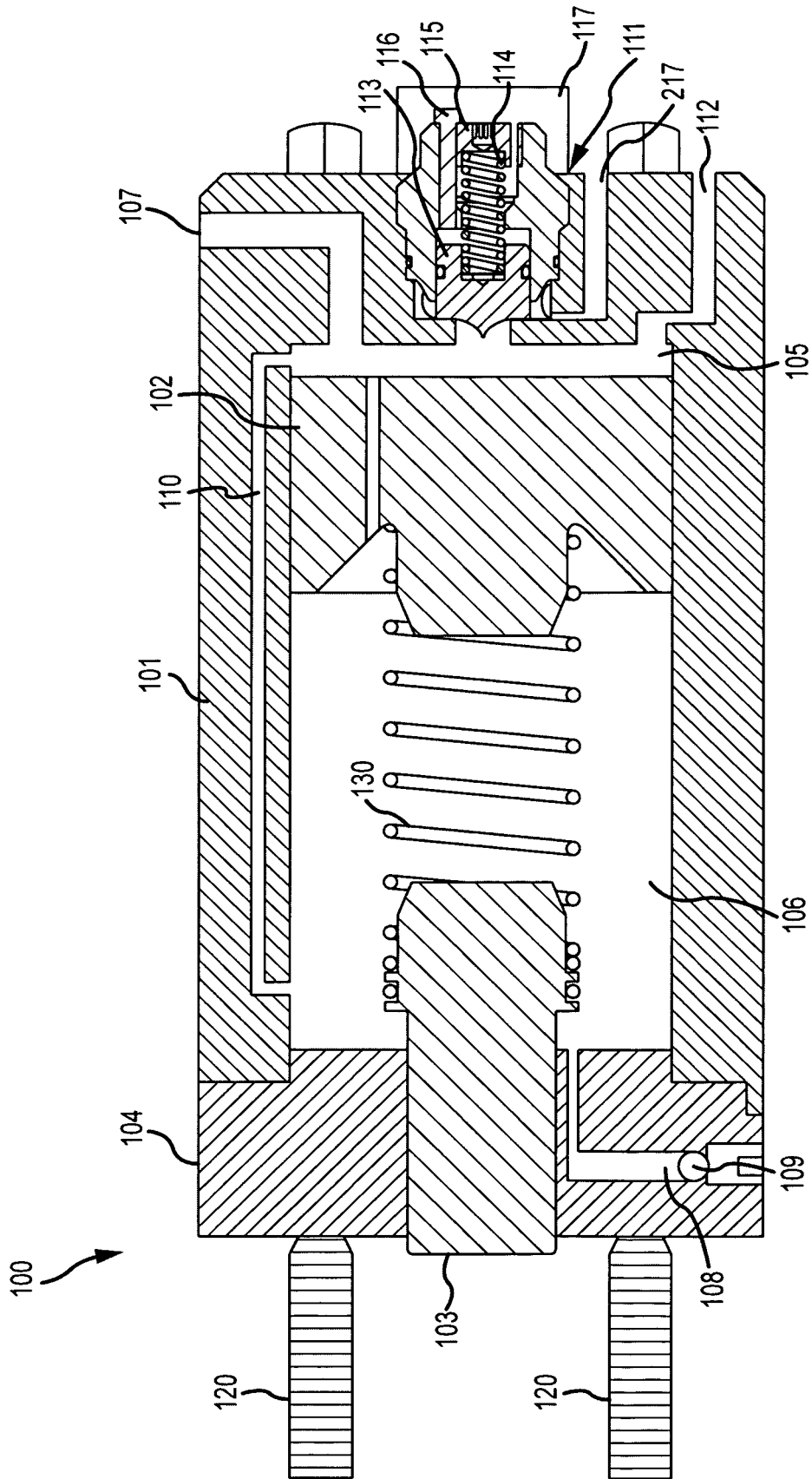


FIG. 2

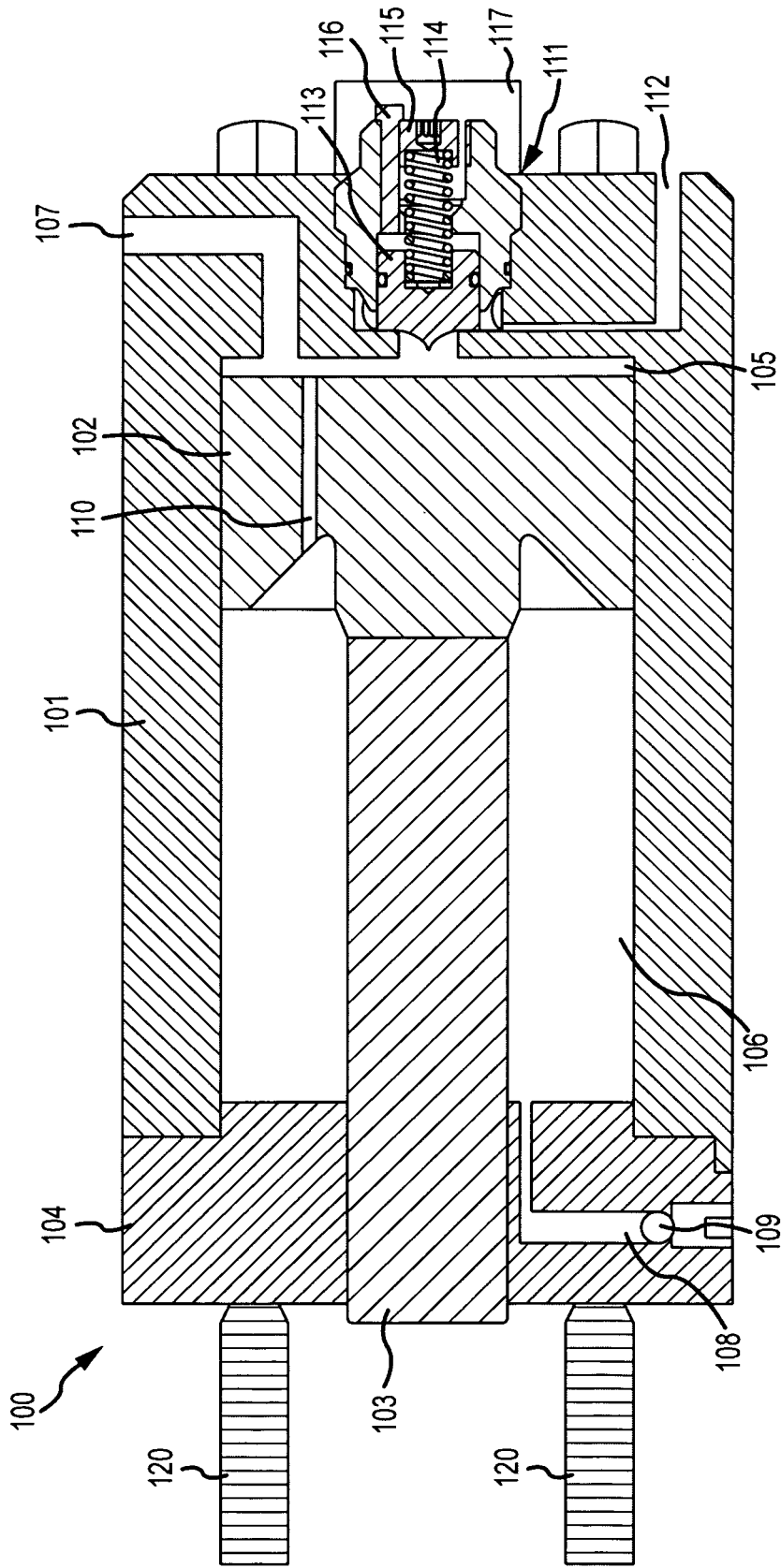


FIG. 3

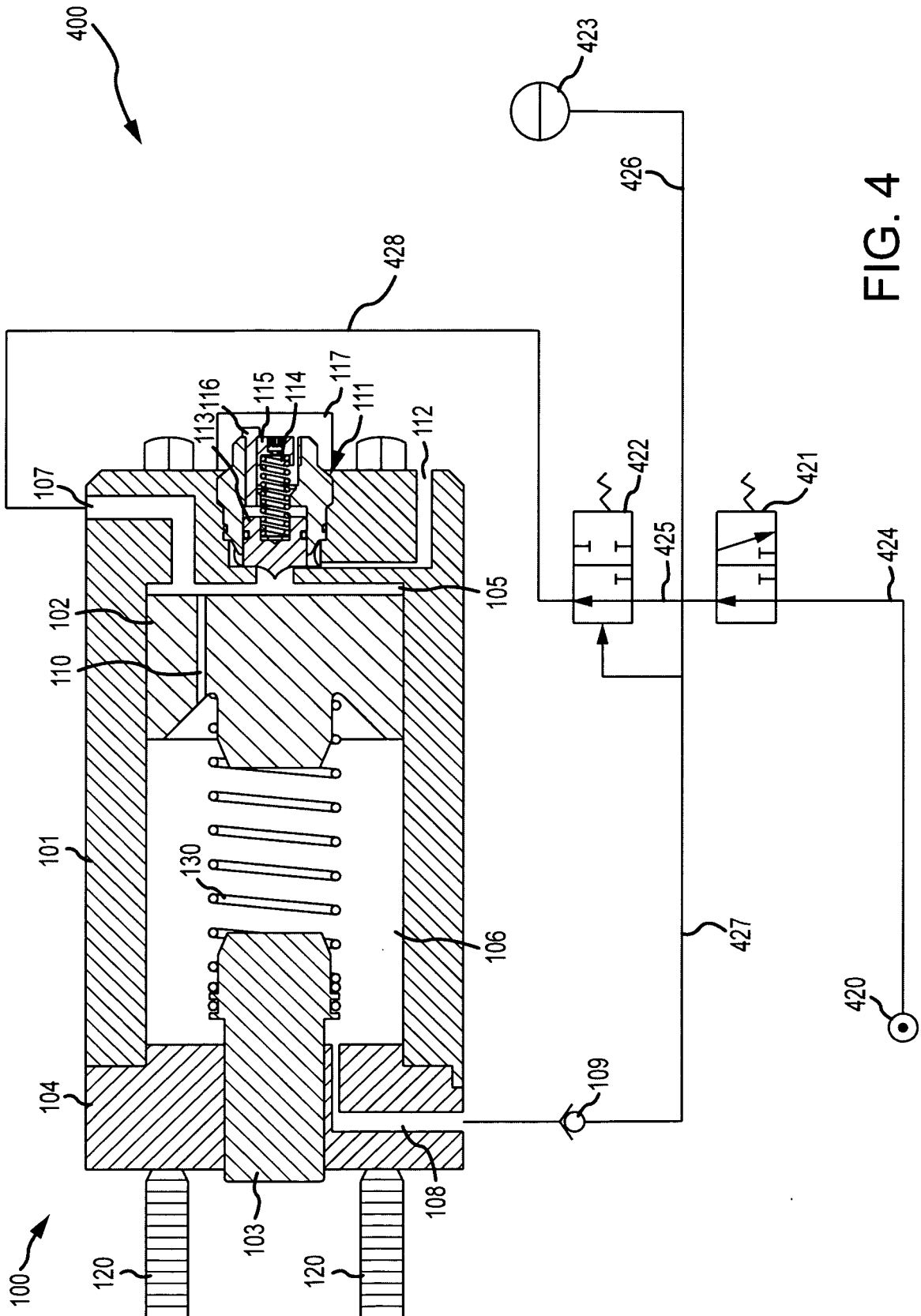


FIG. 4

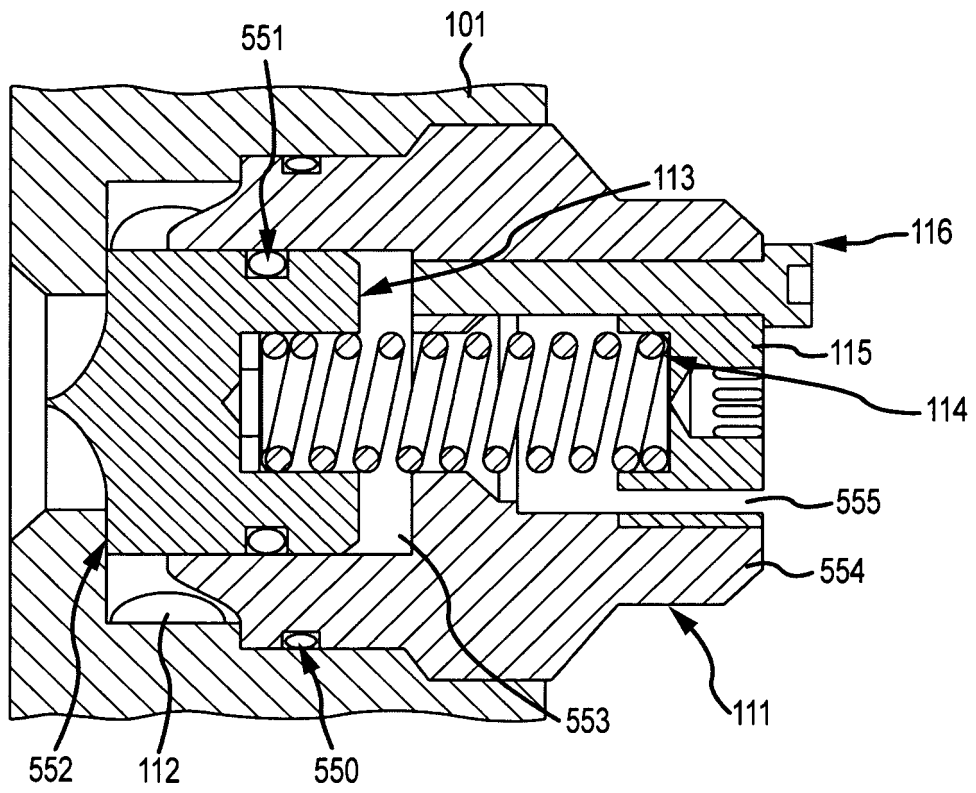


FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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